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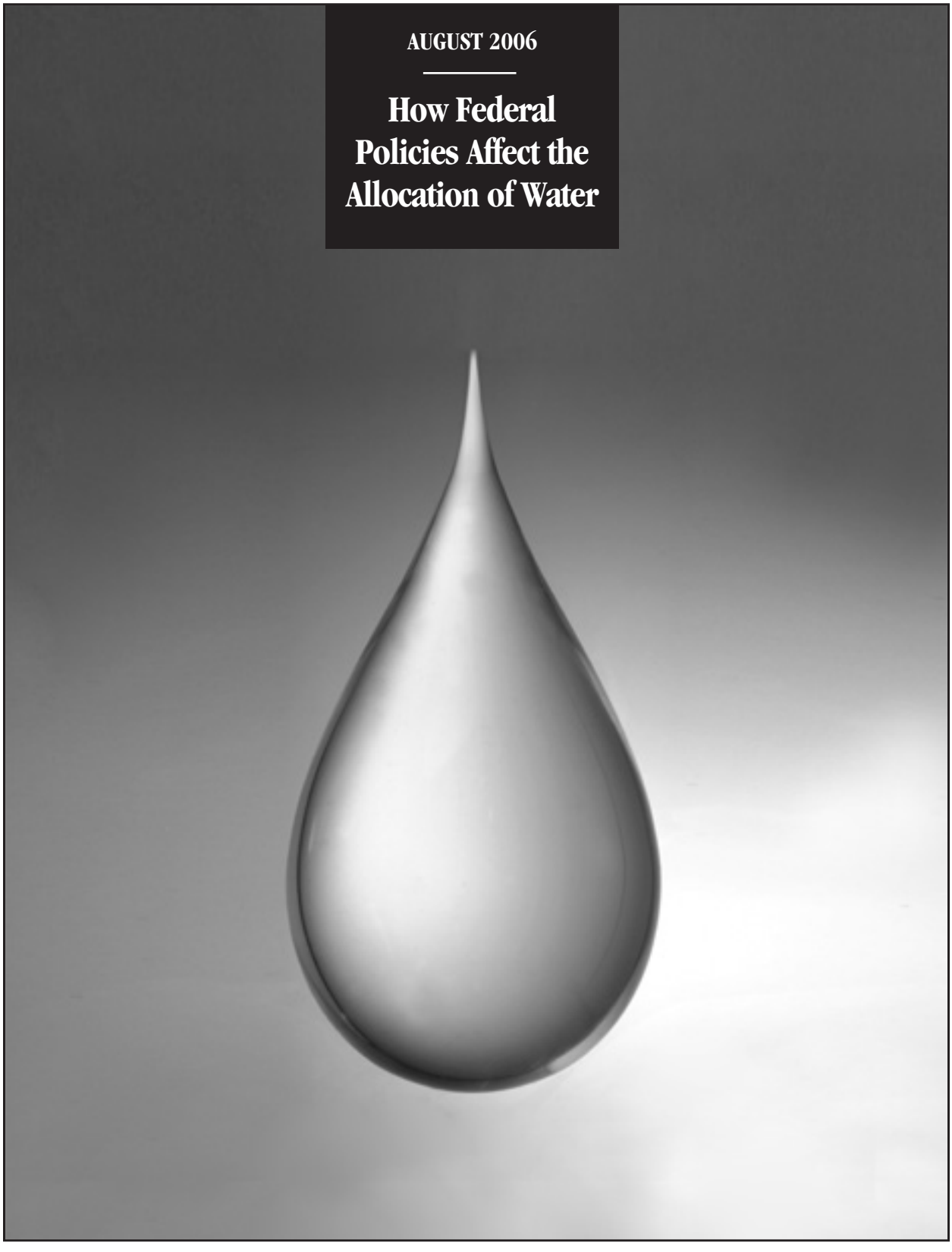
How Federal Policies Affect the Allocation of Water



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How Federal Policies Affect the Allocation of Water

August 2006

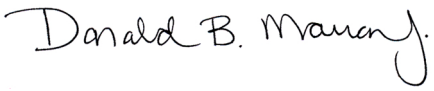
The Congress of the United States ■ Congressional Budget Office

Preface

The drought conditions of recent years have focused attention on the nation's use of freshwater resources. This Congressional Budget Office (CBO) paper examines the mechanisms that govern water allocation, how they affect the benefits that accrue to society from its use of water resources, how those effects might change over time, and what influence federal policies could have on such considerations. The paper was prepared in response to a request from the Ranking Member of the Subcommittee on Water and Power of the House Committee on Resources. In keeping with CBO's mandate to provide objective, impartial analysis, the paper makes no recommendations.

Natalie Tawil of CBO's Microeconomic Studies Division prepared this paper under the supervision of Joseph Kile, David Moore, and Roger Hitchner (formerly of CBO). Greg Hitz, Jim Langley, and Robert Murphy made contributions to the analysis. Bob Dennis, Arlene Holen, Julie Middleton, Bob Shackleton, Derek Trunkey, and Tom Woodward provided comments. Tom Zacarias of National Crop Insurance Services and Craig Bell of the Western States Water Council provided useful information, and Gary Libecap of the University of Arizona reviewed the paper. (The assistance of an external reviewer implies no responsibility for the final product, which rests solely with CBO.)

Christine Bogusz edited the paper, with assistance from John Skeen. Maureen Costantino prepared the paper for publication and designed the cover, and Lenny Skutnik printed the initial copies of the paper.



Donald B. Marron
Acting Director

August 2006

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Summary

Use of the nation's freshwater resources attracts particular scrutiny in times of drought. When water is scarce, people are more aware of its importance. The mechanisms that govern the allocation and use of water are complicated, however. To examine how society uses its water resources, this Congressional Budget Office analysis addresses several major questions:

- What are this country's water sources, and how is the water used?
- What determines the underlying allocation, and does that allocation maximize water's potential benefits to society as a whole?
- What policies might the federal government consider toward that end?

Sources and Uses of Water

In the United States, freshwater resources are drawn from surface sources and groundwater sources. Nationally, surface waters account for about three-quarters of withdrawals; in the arid West, however, groundwater sources supply a larger percentage of withdrawals than in the East.

Nationwide, 40 percent of withdrawals are for agricultural use. In the West, agriculture accounts for 74 percent of withdrawals; in the East, where irrigation is less common, agriculture accounts for 11 percent of withdrawals. Although much of the water withdrawn for agriculture is consumed in irrigation, as much as 20 percent might return to its sources, albeit altered in terms of its content. Another 40 percent of withdrawals nationwide are for thermoelectric power. Those withdrawals return most of the water, altered only in temperature, to its sources. Thermoelectric power accounts for 64 percent of withdrawals in the East and 11 percent in the West. (Hydropower in the West uses only in-stream resources, so it has no associated withdrawals.) Residential, commercial, and industrial entities account for the remaining 20 percent of national freshwater withdrawals.

The Impact of Inflexible Water Allocations

The water withdrawn for those various uses is allocated on the basis of state laws that determine property rights to use it. Market transfers of water—by sale, lease, or exchange—are constrained by the way states define property rights in water use. In the national economy, markets generally use prices to allocate scarce resources across uses and over time to maximize the overall net benefits to society. Markets in water-use rights, however, are not widespread. Water prices typically reflect the expense associated with physically accessing and delivering it. Such prices do not convey the opportunity costs—the economic benefit forgone when water is dedicated to a particular use—and thus do not allocate the resource to its highest-value use.

The state laws governing property rights and the pricing mechanisms that conceal opportunity costs make the current allocation of water relatively inflexible. That inflexibility might become increasingly costly in the future, as it exacerbates pressures on federal spending and reduces the potential gains to the economy from the use of water resources. Four developments in particular augment demand pressures: the settlement of Indian tribes' claims on water rights currently held by others; environmental laws that require greater amounts of water be retained in natural courses; growing populations in arid states; and the recurring impacts of droughts, which may increase in frequency and intensity as a result of shifts in precipitation patterns.

Policy Options to Facilitate Reallocations

Broader use of markets in deciding how scarce water resources are allocated could improve on the current system of administrative allocation that has emerged under state law. Because markets offer flexibility in balancing supply and demand—by providing incentives to reallocate water among users, to use less water, and to provide more water—they could mitigate society's costs of adjusting to changing conditions.

The federal government could facilitate market transfers of water by clarifying the potential for broader water marketing using its jurisdiction under the commerce clause of the Constitution and federally reserved water rights. The commerce clause gives the Congress the authority to allocate interstate waters to serve the national interest—even if doing so means overriding state law. The Congress could clarify legal uncertainties regarding the rights of Indian tribes to lease water to different intrastate and interstate users. The government could also increase its efforts to promote water banks—institutional mechanisms that facilitate the market exchange of various types of surface water and groundwater rights and storage entitlements.

To facilitate efficient water use, policymakers could reconsider subsidies that support the use of water at prices that do not reflect opportunity costs, as well as subsidies for agricultural production that encourage additional planting and excess irrigation. The government could also assess the impact of refining or expanding programs that address the demand for water directly—using approaches such as cost sharing for improvements to irrigation systems and conservation plans for irrigators who get water from federal infrastructure projects.

To encourage the efficient provision of water, policymakers could reexamine the level of federal support for research and development (R&D) to augment supplies. When multiple state and local governments and private-sector entities face a similar problem, they tend to invest too little in R&D because each balances the potential cost against only its own expected benefits, rather than the benefits that can accrue to the economy as a whole. Therefore, policymakers could contemplate the level of federal support for R&D in desalination and water-purification technologies or for the collection of water resources data to refine water management as a public investment that might provide a positive return.

How Federal Policies Affect the Allocation of Water

The Allocation of Water Resources

The nation accesses freshwater from precipitation and underground sources, stores surface water with dams and reservoirs, pumps water from aquifers and uses them for storage, and transports and distributes water through canals and pipes. Surface water makes up 76 percent of the freshwater supply, and groundwater accounts for 24 percent.

In the East, where annual precipitation generally ranges from 30 to 60 inches, 84 percent of freshwater comes from surface sources and 16 percent from groundwater sources. In the West (excluding the Pacific Northwest), where annual precipitation generally ranges from 5 to 20 inches, 67 percent of freshwater comes from surface sources and 33 percent from groundwater sources.

The U.S. Geological Survey publishes data on water withdrawals, but national data on water consumption (withdrawals net of return flows) are not available. The relationship between withdrawals and consumption depends on the type of use and its impact on the quantity and quality of the return flows.

Water Uses

Agriculture accounts for 40 percent of freshwater withdrawals nationally, but the proportion is much lower in the East (11 percent), where irrigation is less prevalent, than in the drier West (74 percent). (See Table 1.) Withdrawals for irrigation are largely consumed. According to data for 2000, well over half of the water used for agriculture was probably consumed, as much as one-fifth was most likely lost in transport, and the remaining one-fifth or so returned to original sources. Such return flows are generally altered in terms of their pesticide, fertilizer, and mineral content.

The production of thermoelectric power also accounts for about 40 percent of freshwater withdrawals nationwide. In the East—where power plants use water from the Great Lakes, major rivers, and the Atlantic ocean for their cooling systems—thermoelectric power production accounts for 64 percent of water withdrawals. In the West, it accounts for only 11 percent, because hydroelectric power, which is more common there, uses only in-stream water resources (and therefore requires no water withdrawals).

Although a relatively large proportion of withdrawals is associated with thermoelectric power, water consumption by that sector is very limited. Once-through cooling systems, which use 88 percent of thermoelectric withdrawals, return water to its source, altered only in terms of temperature, after circulating it through heat exchangers.[1] Less common closed-loop systems recycle the water they use but, in replacing losses, may consume more than half of their withdrawals.

Residential, commercial, and industrial uses account for the remaining 20 percent of freshwater withdrawals. Such withdrawals are higher in the East (roughly 25 percent) than in the West (about 15 percent) and are largely consumed. Return flows, composed primarily of sewage effluent, are a small proportion of withdrawals.[2]

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1. The Environmental Protection Agency's (EPA's) rules effectively prevent the use of once-through cooling by new power plants because of the potential impact on wildlife.

2. See W.B. Solley, R.R. Pierce, and H.A. Perlman, "Estimated Use of Water in the United States in 1995," Circular 1200 (Reston, Va.: U.S. Geological Survey, 1998), and S.S. Hutson and others, "Estimated Use of Water in the United States in 2000," Circular 1268 (Reston, Va.: U.S. Geological Survey, 2004).

Table 1.

Freshwater Withdrawn from Surface and Groundwater Sources, by Category of Use and Region, 2000

(Percent)

	United States			East			West		
Category of Use	Surface	Ground	Both	Surface	Ground	Both	Surface	Ground	Both
Irrigation and Livestock	31	70	40	4	48	11	70	81	74
Thermoelectric Power	52	0	39	76	1	64	16	0	11
Public Supply[a] and Self-Supplied Residential	10	23	14	11	38	15	10	15	12
Self-Supplied Industrial	6	4	5	8	9	8	2	2	2
Aquaculture and Mining	1	2	2	1	4	1	2	1	2
Total	**100**	**99**	**100**	**100**	**100**	**99**	**100**	**99**	**101**

Source: Congressional Budget Office based on data from S.S. Hutson and others, "Estimated Use of Water in the United States in 2000," Circular 1268 (Reston, Va.: U.S. Geological Survey, 2004).

Note: The relationship between water withdrawals and water consumption depends on the type of use and its impacts on the quantity and quality of return flows. The U.S. Geological Survey currently publishes data on water withdrawals but not water consumption.

a. These are public and private suppliers serving at least 25 people or having at least 15 connections. The water may be for residential (56 percent in 1995), commercial (17 percent), or industrial purposes (12 percent) or for thermoelectric power (0.3 percent). During 2000, suppliers in this category provided about 85 percent of the nation's population with drinking water.

Private Rights to Use Water and the Impact on Potential Reallocations

State laws determine private property rights to use water, but those rights are incomplete.[3] Reallocations are constrained under state laws in two respects. First, the laws incorporate restraints on water use, and thus on water transfers, that would interfere with the water rights of others. Second, in times of water shortages, holders of water rights are either subject to proportional reductions in use or obliged to reduce their use to ensure that those who preceded them in obtaining rights to the same source of water can claim their full allocation. Those two elements of state law differ in form under the riparian doctrine common in the East and the prior appropriation doctrine common in the West.

Rights Under the Riparian Doctrine. In the East, the ownership of land adjacent to a body of water (riparian land) generally conveys the right to use the water in a way that is "reasonable." A qualifying landowner may initiate new uses at any time, and others may need to adjust their use in response. Any qualifying landowner can make "natural" use of the water (to meet his or her residential needs) regardless of the consequence to others who own riparian land. "Artificial" uses (for irrigation and industrial purposes) are subject to restrictions on the basis of the reasonableness of the use.[4] Determining what is reasonable involves consideration of the purpose of the use, the suitability of the use to the body of water, economic and social values of the use, the extent of harm caused, the practicality of avoiding any harm by adjusting the methods or quantities of use, and the fairness of making the user who causes harm bear losses. When the water supply is deemed insufficient to satisfy the reasonable needs of all qualifying landowners, they must reduce their use in proportion to their rights—sometimes based on the amount of adjacent land they own.

3. For a discussion of the origin and evolution of state water law, from which this discussion draws heavily, see David Getches, *Water Law in a Nutshell*, 3rd ed. (St. Paul, Minn.: West Publishing Co., 1997).

4. In practice today, owners of riparian land must obtain permits from a state agency to use water. Permits may also be available to others who do not own riparian land. The charters incorporating most cities give them power to procure water for public purposes and to supply the domestic needs of their residents, and states have modified the riparian doctrine by introducing exceptions that allow municipal uses.

Under the riparian doctrine, water rights transfer with the transfer of land. A qualifying landowner can transfer the water rights separately only if the recipient uses the water on the riparian land and meets the test of reasonable use. An owner of riparian land cannot transfer water out of a watershed.

Rights Under the Prior Appropriation Doctrine. In the West, the right to use a quantity of water generally belongs to anyone who first diverts that water from its natural setting and puts it to a "beneficial use" anywhere. A water right is specified in terms of the date it is established, its purpose of use, the quantity of water, the rate of flow, the point of diversion, and the time when the water may be taken. The right remains valid as long as it continues to be used for the purpose for which it was established. All states relying on the prior appropriation doctrine consider agricultural, residential, commercial, and industrial uses to be beneficial. Most states accept recreation as a beneficial use, and some specify that scenic or aesthetic uses are also beneficial. The doctrine shields appropriators' rights from impingement associated with changes in the terms of water rights and accords no preference to uses with higher relative economic or social value compared with uses established earlier in time.[5] When water is in short supply, rights-holders who have made appropriative claims earlier (senior appropriators) have priority over parties who made later claims to water from the same source—those junior appropriators may receive only some, or none, of the water to which they have rights.

Under the doctrine of prior appropriation, water rights can be conveyed with a transfer of land and retain their priority, but an appropriator can transfer the water rights separately (for use on a different parcel of land, for a different purpose, at a different time, or with a change in the point of diversion) only if the transfer does not impair other appropriators' ability to exercise their vested rights. A transfer impairs rights if it results in other appropriators being deprived of water (in terms of its quantity or quality) or if their obligations to senior appropriators mount, as exemplified in the following situation. Most senior appropriative rights belong to irrigators. Transferring those rights may harm downstream users whose appropriations rely on return flows from irrigation. Protecting the rights of those junior appropriators can frustrate water transfers from agriculture to potentially more productive municipal or industrial uses.[6] Junior appropriators may also claim harm if they are deprived of the return flows from change in a senior appropriator's use—if, for instance, the senior appropriator uses less water-intensive crops or more-efficient irrigation systems, salvages water, and transfers it for use on different land or for new purposes.[7]

Transferring water outside a watershed is not expressly prohibited under the prior appropriation doctrine, but various state laws limit such transfers through requirements to protect the equities and interests of the area of origin. For example, Nebraska prohibits transfers from agriculture to other uses,[8] and Idaho does not allow transfers that "would significantly affect the agricultural base of the local area."[9] Some states explicitly restrict the right to use water outside the watershed where it originates. Their statutes focus mostly on intrastate exports, but some, like Alaska's, address interstate exports. (See Box 1.)

Rights to Use Groundwater. The rights to use groundwater may be based on the notion that water is a shared public resource, on ownership of overlying land, or on

5. Generally, states require users to obtain permits to appropriate water. The states issue those permits on the basis of requirements designed to protect water users and consider the public interest. Some state courts have held that states have a "public trust" obligation not to allow water to be used inconsistently with public purposes. Although water rights manifested in a permit are rarely disturbed, the public trust doctrine may negate existing appropriations that are contrary to the public interest.

6. Rather than using rights to withdraw water as the basis for transfers, some observers suggest basing transfers on water consumption so that the water associated with the return flows from the now-transferred appropriative rights is retained in the original watershed. One problem with that approach is that consumptive use is difficult to measure. See Terry Anderson and Ronald N. Johnson, "The Problem of Instream Flows," *Economic Inquiry*, vol. 24, no. 4 (1986), pp. 535-553; and Ronald N. Johnson, Micha Gisser, and Michael Werner, "The Definition of a Surface Water Right and Transferability," *Journal of Law and Economics*, vol. 24, no. 2 (1981), pp. 273-288.

7. If recapture and reuse of water occurred within the original land and for the original purpose, it would be allowed without regard to the harm caused to a downstream appropriator, as long as the amount diverted did not exceed the amount originally specified in the permit.

8. Neb. Rev. Stat. §46-294(1)(I).

9. Idaho Code §42-222(1).

Box 1.

Apportioning Interstate Water Resources

Sources of water are not neatly confined by state borders. For interstate surface water, states clarify their administrative division through compacts, which are Congressionally ratified agreements. The Colorado River Compact, for example, aims to divide the river's water between the Upper Basin states (Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin states (Arizona, California, and Nevada). In 1922, the compact's signatories had one estimate of the river's average annual flow of 16.8 million acre-feet, based on an examination of river flows from 1896 to 1921.[1] A second estimate, based on river flows from 1906 to 1921, put the average at 18.1 million acre-feet. The agreement essentially splits the difference and relies on an average annual flow of 17.5 million acre-feet. (In fact, it apportions more water than actually exists.[2] Studies of river flows over the past 400 years, based on an analysis of tree rings, have put the average annual flow at 13.5 million acre-feet.)

For interstate groundwater, the laws of each state govern access to and use of an aquifer's resources withdrawn in its jurisdiction, even if those resources are accessible from multiple states. For example, there is no coordinated apportionment, even for the largest aquifer crossing state boundaries—the High Plains aquifer, which extends over 174,000 square miles and involves eight states: Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming.

1. One acre-foot is the volume of water that would cover one acre to a depth of one foot. Equivalent to 325,851 gallons, it approximates the amount of water used by a four- to five-person household over a period of one to two years.

2. The states of the Upper Basin have never used their full apportionment of 7.5 million acre-feet. As of 2000, they used about 4.8 million acre-feet. Recent projections suggest their use will increase by about 700,000 acre-feet by 2025 and by nearly 1.1 million acre-feet by 2050. See Robert Jerome Glennon and Peter W. Culp, "The Last Green Lagoon: How and Why the Bush Administration Should Save the Colorado River Delta," *Ecology Law Quarterly*, vol. 28, no. 4 (2002), pp. 916-917.

established uses (or some combination of those three). Most states do not recognize private ownership rights to groundwater and consider it subject to management as public property; as a result, users could lose access to the resource and have no recourse. States that rely on the correlative rights doctrine limit landowners to a "reasonable" share of the total groundwater supply, usually based on the acreage they own.[10] States that recognize prior appropriation rights to groundwater may modify the doctrine to set reasonable pumping levels.[11] The exercise of private rights by owners of overlying land or appropriators is governed by the tort doctrines of nuisance and negligence, which impose liability for harm to other users and property owners.

The Role of Prices in Facilitating Reallocations

Market economies rely on prices to allocate resources among uses and over time to make the most efficient use of them. Although some functioning water markets

10. Under the absolute ownership doctrine, landowners have an unlimited right to withdraw water found beneath the land they own. There are no restrictions on use and no liability for causing harm to other owners of overlying land. Only Texas assigns groundwater rights on the basis of absolute ownership.

11. Some states control the mining of aquifers so that depletion occurs over a predictable number of years, and some western states identify "critical areas" where new well drilling and pumping may be severely curtailed or prohibited.

exist,[12] water prices, rather than incorporating the opportunity costs of a given use, more commonly reflect only the expenses associated with physically accessing and delivering water that is administratively allocated according to state law. The prices may also be influenced by government subsidies. For example, subsidies have reduced water prices paid by irrigators in western states and provided part of the investment in public water systems nationwide. When markets for a resource are few, and the prices charged for that resource arbitrary, it is likely that the resource will not be efficiently allocated.

Agriculture. The federal government, through the Bureau of Reclamation, is the "wholesale" supplier of about half of the surface water withdrawn for irrigation. (Surface water accounts for about 60 percent of irrigation withdrawals.) The bureau's 250 or so dams and nearly 350 storage reservoirs in 17 western states divert more than 40 million acre-feet of water from rivers.[13] (About one-quarter of the water that is diverted is lost in operational spills and transport, yielding a supply of about 30 million acre-feet.) More than 25 million acre-feet is withdrawn for irrigation, and the rest is for residential, commercial, and industrial uses.[14] The "retail" suppliers of surface water for almost all irrigators are nonprofit entities, mainly irrigation districts, that enter into supply contracts for water deliveries and use their conveyance systems to distribute water to their members. The estimated average price charged by those entities for such water (largely in the West) was $16 per acre-foot delivered in 1998.[15] (Prices for groundwater are comparable; see Box 2.)

Subsidies by the Bureau of Reclamation have reduced the prices that irrigators pay for water. In constructing western water projects, with the original aim of encouraging settlement, the federal government spent $24.0 billion (in nominal dollars) from 1902 to 2004. Under reclamation law, $19.3 billion of that is "reimbursable"—to be repaid by the projects' beneficiaries. Irrigators are responsible for 46 percent of the total, with power users followed by municipal and industrial water users responsible for the rest. Determinations by the federal government that irrigators were not able to pay shifted $2.9 billion of their $8.9 billion debt to other project beneficiaries, primarily power users.[16] Also, lawmakers, through specific legislation, and the courts subsequently reclassified $2.7 billion of irrigators' debt as nonreimbursable. As of 2004, irrigators had repaid $1.3 billion of their remaining $3.3 billion debt.[17]

For irrigators, the Bureau of Reclamation bases its water supply charges on recovering the associated capital costs and operation and maintenance (O&M) costs for the federal facilities. Irrigators' interest-free payments—which are due over a 40- or 50-year period—do not incorporate the opportunity costs of the federal expenditures. Over a 40-year repayment period at a borrowing cost of 4 percent annually, the government recovers only

12. To find out about the characteristics necessary for a functioning market, see B.C. Saliba and D.B. Bush, *Water Markets in Theory and Practice: Market Transfers, Water Values, and Public Policy* (Boulder, Colo.: Westview Press, 1987). For a comparison of specific markets, see D.S. Brookshire and others, "Market Prices for Water in the Semi Arid West," *Water Resources Research*, vol. 40 (2004). Studies of individual markets and their challenges can be found in K.D. Frederick, "Marketing Water: The Obstacles and the Impetus," *Resources,* vol. 132 (1998), pp. 7-9; R.A. Kaiser and L.M. Phillips, "Dividing the Waters: Water Marketing as a Conflict Resolution Strategy in the Edwards Aquifer Region," *Natural Resources Journal*, vol. 38 (1998), pp. 411-444; and R.C. Griffen and F.O. Boadu, "Water Marketing in Texas: Opportunities for Reform," *Natural Resources Journal*, vol. 32 (1992), pp. 265-288. More formal modeling of water markets in the context of specific problems can be found in M.L. Weber, "Markets for Water Rights Under Environmental Constraints," *Journal of Environmental Economics and Management*, vol. 42 (1999), pp. 53-64; and M. Weinberg, C.L. Kling, and J.E. Wilen, "Water Markets and Water Quality," *American Journal of Agricultural Economics*, vol. 75 (1993), pp. 278-291.

13. One acre-foot is the volume of water that would cover one acre to a depth of one foot. Equivalent to 325,851 gallons, it approximates the amount of water used by a four- or five-person household over a period of one to two years.

14. The diversions amount to between 40 percent and 85 percent of the annual flow of major western rivers such as the Colorado, Rio Grande, Sacramento, San Joaquin, and Snake.

15. Ralph Heimlich, *Agricultural Resources and Environmental Indicators*, Agricultural Handbook No. AH722 (U.S. Department of Agriculture, Economic Research Service, February 2003).

16. Because that transferred obligation is generally scheduled to be credited at or near the end of a project's repayment period, $94.5 million in revenues from power users had been dedicated to repay the federal government by 2004.

17. E-mail communication from Karl J. Stock, Office of Program and Policy Services, Bureau of Reclamation, July 24, 2006.

Box 2.

"Pricing" Groundwater in Agriculture

Groundwater accounts for about 40 percent of total irrigation withdrawals and the major share of on-farm water resources. The costs of accessing groundwater involve capital expenditures for wells, pumps, and power plants, and the costs of the energy needed to power the pumps. In 1998, typical capital costs to access on-farm groundwater resources were in the range of $20,000 to $200,000. The Department of Agriculture estimated total U.S. energy expenditures for all on-farm irrigation water pumping at more than $1.2 billion in 1998. Average energy expenditures were $32 per acre. (Energy costs vary widely, depending in part on the depth of the water, the efficiency of the pumping system, and the needs for pressurization.) An estimate of the average energy cost per acre-foot of water, using the national average total depth of water applied from all sources through the irrigation season in 1998 (20.9 inches), would be about $18.[1]

1. Ralph Heimlich, "Agricultural Resources and Environmental Indicators," Agricultural Handbook No. AH722 (Department of Agriculture, Economic Research Service, February 2003).

49 percent of its true cost. In some instances, the reimbursable costs of existing reclamation projects have yet to be recovered, and water users' payments may not even cover O&M costs (see Box 3).

Public Supply. The public supply of water comes primarily from local or regional public entities or from privately owned concerns that take in, treat (in most cases), and distribute the resource. Two-thirds of retail water deliveries are for residential use, 13 percent are for commercial and industrial uses, and the remaining 20 percent are for agricultural and other uses. The average prices for residential and nonresidential water delivery were $1,013 per acre-foot and $1,147 per acre-foot, respectively, in 2000.[18] In that year, water providers obtained one-fifth of the public supply from wholesalers at an average price of $580 per acre-foot.[19]

Direct federal spending and federally supported spending by states and municipalities have also subsidized the provision of public water. Although public water supply systems are built primarily by local communities and financed mainly by users, over time providers have failed to take in adequate revenues for procuring and treating supplies and for operating, maintaining, and replacing their water infrastructure. The federal government supports those systems through various spending programs—including the Drinking Water State Revolving Funds and loans and grants administered by the Rural Utilities Service of the Department of Agriculture—and, to a lesser extent, through tax preferences. In 1999, subsidies

18. Environmental Protection Agency, *Community Water System Survey 2000, Volume I: Overview*, EPA 815-R-02-005A (December 2002). Average water sales and water-related revenues, from which the agency derived those average prices, increased by 12 percent in real (inflation-adjusted) terms between 1995 and 2000.

19. Ibid. The differential does not appear to be explained by treatment costs. Seventy-one percent of all water systems treat their water, and wholesalers treat over three-fourths of their deliveries. Only a portion of the price difference between agricultural and public water supply uses can be attributed to treatment and basic transportation costs. For example, with irrigation contract prices of $2 to $31 per acre-foot for Central Valley Project water in California during the late 1990s, prices for an acre-foot of water charged by most of the state's urban water suppliers approached or exceeded $1,000. Between $100 and $300 of the price difference is explained by the treatment and transportation costs of providing the water to municipal areas in the southern and coastal portions of the state. See Marca Weinberg, "Assessing a Policy Grab-Bag: Federal Water Policy Reform," *American Journal of Agricultural Economics*, vol. 84, no. 3 (August 2002), pp. 541-556.

Box 3.

Paying for California's Central Valley Project

California's Central Valley Project—the country's largest water supply project—began deliveries in 1940 and was completed in 1979. Irrigators are responsible for paying $1.3 billion of the project's federal construction cost of $3.6 billion (in nominal dollars). Originally, irrigators had renewable 40-year water service contracts that provided for water deliveries but not necessarily for repaying the $1.3 billion by the end of the contract term. The Bureau of Reclamation intended for the contract prices to cover only operation and maintenance (O&M) expenses and a portion of construction costs. However, the prices were not even sufficient to cover O&M expenses, which increased over time. Deficits accrued in the O&M accounts, and no payments were made for construction costs.[1]

In 1986, federal legislation imposed a final repayment deadline of 2030 for all Central Valley Project facilities located within the Sacramento-San Joaquin valleys. According to the most recent figures available, as of September 30, 2004, irrigators had met 14.2 percent of their total repayment obligation.[2] The Bureau of Reclamation has recently renegotiated expiring water service contracts, and new 25-year contracts went into effect in the spring of 2006. Questions remain as to whether the contracts provide for meeting capital repayment obligations by 2030, however.[3]

1. Congressional Budget Office, *Water Use Conflicts in the West: Implications of the Bureau of Reclamation's Water Supply Policies* (August 1997).

2. See the Central Valley Project's Schedule of Irrigation Capital Rates by Contractor, 2006 Irrigation Water Rates, Schedule A-2Ba, available at www.usbr.gov/mp/cvpwaterrates/ratebooks/irrigation/2006/IRR%202006%20Sch%20A-2Ba%20F.Z08.pdf.

3. Letter from Joel D. Kaplan, Deputy Director, Office of Management and Budget, to Representative George Miller, September 13, 2004.

provided the equivalent of 10.8 percent of the total investment in water systems.[20]

Opportunity Costs. Prices based on the costs of accessing and delivering water, and influenced by subsidies, bear little relation to the opportunity costs of water use—the value that society places on the best alternative use. Opportunity costs (which are better reflected in market-determined prices) play an important role in determining whether society's use of a resource is achieving the greatest possible net benefits when the productivity associated with an additional unit varies among alternative uses.

Various studies have concluded that the value of one additional unit of water used in agriculture is generally less than in industrial or municipal uses.[21] In the case of agricultural use, that conclusion depends on the amount of water used in crop production and the price of the crop produced.[22] A 2003 study of a specific out-of-basin transfer of surface water originally used for agriculture

20. See Congressional Budget Office, *Future Investment in Drinking Water and Wastewater Infrastructure* (November 2002), p. 38. That estimate applies to the combined investment in drinking water and wastewater systems.

21. A 1983 study put the range of the value for an additional acre-foot of water in agriculture at $9 to $103. For water in domestic uses, the range was $19 to $322; for water in industrial uses, it was zero to $160; and for water in recreational uses, $2 to $17. (See Office of Technology Assessment, *Water Related Technology for Sustainable Agriculture in US Arid/Semiarid Lands*, OTA-F212, 1983, as referenced in William Boggess and others, "Economics of Water Use in Agriculture," in *Agricultural and Environmental Resource Economics*, Gerald A. Carlson and others, eds. (New York: Oxford University Press, 1993, pp. 319-391.) Also see Gary Libecap, *Transaction Costs: The Owens Valley Transfer to Los Angeles*, Working Paper No. 10801 (Cambridge, Mass.: National Bureau of Economic Research, 2004); and National Research Council, Water Science and Technology Board, *Water Transfers in the West: Efficiency, Equity, and the Environment* (Washington, D.C.: National Academies Press, 1992), p. 150.

22. Heimlich, *Agricultural Resources and Environmental Indicators*.

found large improvements in the net benefits that society could obtain from its use of water—an annualized 67 percent increase in overall social welfare.[23] A 1984 study modeling comprehensive intrastate water trading in California found that moving 11.5 percent of total agricultural water supplies to urban uses in 2020 would equalize the value of an additional unit of water (net of transport and other costs) among different sectors, maximizing the net benefits to society.[24]

More broadly, a 1992 study modeled intrastate and interstate trading for Colorado River water, taking into account not only the economic values in agricultural and municipal/industrial uses but also the values of some nonconsumptive uses such as in-stream flows for hydropower production. The researchers concluded that consumptive-use markets alone would yield 50 percent (intrastate markets) to 64 percent (intrastate and interstate markets) of the total possible improvement in net social benefits from optimal water allocation when values associated with the nonconsumptive uses of water were also considered.[25]

Large differences between the net benefits to society from actual water use and the hypothetical best use are not surprising given that a 1986 survey of 196 Bureau of Reclamation-supplied irrigation districts (which account for more than 70 percent of total irrigated acreage in bureau-supplied districts) indicated that many users faced a price of zero for an additional unit of water. Forty-eight percent of the districts assessed their members a fixed charge per acre that was independent of the amount of water delivered. Thirty-eight percent of the districts coupled a fixed charge for an initial volume of water with a quantity-based rate for excess use. However, that quantity-based rate was typically not triggered in normal years, so those irrigators generally also faced a price of zero for an additional unit of water.[26] In 1997, when researchers revisited the districts, the situation was largely the same—district prices provided little information to irrigators about the opportunity costs of using an additional unit of water.[27] In 2004, the prices faced by irrigators on the western slope of the Rocky Mountains in Colorado for an additional unit of water ranged from zero to $6.52 (per acre-foot), while municipalities in the same counties charged between $326 and $1,026 (per acre-foot at average volumes used by four- or five-person households).[28]

The Increasing Costs of Inflexible Water Allocations

Currently, constraints on reallocating water are embodied in state laws and in pricing mechanisms that mask opportunity costs. Over time, inflexible allocations may exacerbate pressures on federal spending and reduce the net benefits that society derives from water use because of four developments augmenting demand pressures: the settlement of Indian tribes' water-rights claims, environmental laws requiring that greater amounts of water be retained in natural courses, shifts in the population toward arid states, and the possibility that changing precipitation patterns as a result of climate change could intensify droughts.

23. Keith C. Knapp and others, "Water Transfers, Agriculture, and Groundwater Management: A Dynamic Economic Analysis," *Journal of Environmental Management*, vol. 67 (2003), pp. 291-301. The transfer prompts an increase in the use of groundwater for agriculture and a reduction in the replenishment of the affected aquifer. If the market incorporates the effects on the water table level, the water sellers obtain relatively small gains from the transfers.

24. H.J. Vaux and R.E. Howitt, "Managing Water Scarcity: An Evaluation of Interregional Transfers," *Water Resources Research*, vol. 20 (1984), pp. 785-792.

25. J.F. Booker and R.A. Young, "Modeling Intrastate and Interstate Markets for Colorado River Water Resources," *Journal of Environmental Economics and Management*, vol. 26 (January 1994), pp. 66-87.

26. The quantity-based rate, when triggered, was either decreasing with the volume used (so irrigators faced a declining price for additional use) or constant in 86 percent of those districts. The remaining 14 percent used a purely quantity-based rate and almost all of them had a constant per-unit price.

27. A.M. Michelsen and others, "Emerging Agricultural Water Conservation Price Incentives," *Journal of Agricultural and Resource Economics*, vol. 24, no. 1 (1999), pp. 222-238.

28. Those numbers come from Western Resource Advocates, *Water Rate Structures in Colorado: How Colorado Cities Compare in Using This Important Water Use Efficiency Tool* (September 2004) and from the Congressional Budget Office's interviews with the six western slope irrigation districts—all of which obtained water from federally financed projects.

Water-Rights Claims of Indian Tribes

The water-rights claims of Indian tribes began to be settled through restrictions on state water allocations in the late 1970s. The Supreme Court had earlier ruled that when the federal government established an Indian reservation, by implication it reserved enough water to "fulfill the purposes for which the reservation was made."[29] The reservation's establishment date set the priority of the water rights, which are not subject to forfeiture for nonuse. Even though states did not account for those "federally reserved" rights as users were appropriating water, the federally reserved rights, when finally asserted, have seniority over water rights established under state laws of prior appropriation because Indian reservations predate many non-Indian settlements.

To accommodate the emerging demand for water, the federal government has helped states and tribes negotiate settlements that quantify the federally reserved rights and provide the associated water resources by restricting state water allocations. To date, the Congress has approved 20 Indian water-rights settlements, beginning with the Ak-Chin Indian Water Rights Settlement Act of 1978 and including the recent Arizona Water Settlements Act of 2004. In the context of those settlements, the federal government spent, or committed to spend, at least $1.7 billion—directing the funds to affected irrigation districts and to Indian communities for economic development.

By redefining senior-most water-use rights, the settlement of Indian tribes' water-rights claims may offer a way around some restrictions on market transfers of water resources. Considerable amounts of water might be made available to markets if some of the constraints associated with the rights as currently held by non-Indian irrigators no longer exist—tribes hold sizable (as yet unexercised) rights over large quantities of water. Under the Supreme Court's 1963 *Arizona v. California* decision, tribes are legally entitled to the amount of water needed to irrigate all practically irrigable acreage within their reservation boundaries, and tribes own large amounts of land in the western states.[30] In Arizona, for example, 19 reservations account for 20 million acres, or 28 percent, of the land in the state. The water rights associated with Wyoming's 1.2-million-acre Wind River Reservation affect the entire Bighorn Basin—which makes up 21 percent of the state's land area and most of its irrigated land. Indian reservations also account for more than 10 percent of the land in New Mexico and 6 percent in Washington.

Environmental Laws

The Endangered Species Act of 1973 has prompted federal expenditures addressing issues of water supply and allocation. Among the 663 species listed as "threatened" or "endangered" in 1995, 141 were affected by the diversion or drawdown of surface water, 82 by water-level fluctuation, 26 by water-level stabilization, 61 by water-temperature alteration, 103 by reservoirs, 71 by the drawdown of groundwater, and 14 by alteration of water's salinity. Perhaps the best-known example of such expenditures are those associated with the multipurpose California Bay-Delta Restoration Program (CALFED), which has received about $325 million in federal funding during the 1998-2006 period. Other examples include $72 million (from 1989 through 2000) for the cooperative agreement for the Upper Colorado Endangered Fish Recovery Program, over $35 million for the 1997 cooperative agreement for Platte River research and other efforts relating to endangered species' habitats along the Central Platte River, and $11.5 million for a 2005 cooperative agreement to aid four endangered species of fish in Colorado's Yampa River Valley.

Beyond expenditures to ensure compliance with the act, the government has incurred compensation costs because of related changes in water-use patterns; such costs could mount over time. The federal government was held financially liable in April 2001, and later charged $13.9 million plus interest, for diverting water from California irrigators to serve the needs of endangered species in 1992 and 1994.[31] The U.S. Court of Claims found that the diversions amounted to a physical (not regulatory) taking of irrigators' private property. The body of law that the courts apply in judging a taking claim allows the government considerable latitude to regulate without causing a taking. Thus, the courts find that most federal restric-

29. *Winters v. United States,* 207 U.S. 564, 577 (1908). In 1976, the Supreme Court ruled that the federal government had reserved water rights for any land set aside from the public domain for a particular purpose (*Cappaert v. United States*, 426 U.S. 128). The ruling applies to national forests, national parks, national wildlife refuges, and wild and scenic rivers.

30. *Arizona v. California*, 376 U.S. 340 (1963).

31. *Tulare Lake Basin Water Storage District v. United States*, 49 Fed. Cl. 313 (2001)

tions do not constitute a taking unless they entirely eliminate the value of the regulated property or some fundamental right of ownership. In this case, the court decided that by preventing the affected farmers from using as much as a third of their water deliveries, the government had deprived them of the entire value of their contract right, creating a "complete extinction of all value" that amounted to a physical taking of property. It was the first time the courts found that environmental restrictions on the exercise of water rights could amount to such a taking in the context of the Endangered Species Act.

It is not clear how changes in water allocation related to environmental laws will affect the net benefits that society derives from its use of water resources. Allocation under prior appropriation tended to ignore the benefits associated with water in its natural course because, to establish a water right, a user had to divert or withdraw water. Only recently have state laws recognized rights to use water beneficially as it flows naturally. Determining the optimal allocation would necessitate establishing the value of those environmental benefits. But they are difficult to quantify. Although most western states now recognize in-stream water rights in some form, water-rights purchases and leases for in-stream flows represent only a small fraction of water-rights transactions in the West.[32] The power of the market to reallocate the resource to in-stream flows is limited because in most states a public entity must hold the rights to instream flows and private citizens cannot purchase such rights.[33]

Population Shifts to Arid States

The five U.S. states with the fastest-growing populations in percentage terms from 1990 to 2000 were all in the West. Ranked first was Nevada (at 66.3 percent), followed by Arizona (40.0), Colorado (30.6), Utah (29.6), and Idaho (28.5). California was first in absolute terms with more than 4.1 million new residents, but it ranked 18th in percentage terms.[34] There was also notable growth in the Southeast. Georgia's population growth was the sixth largest in the nation (26.4 percent), followed by Florida's (23.5).

In some of those states where freshwater withdrawals have grown along with the population, the federal government has undertaken large-scale ecosystem-restoration initiatives that are linked with the urban demand for water. The government has, for example, committed financial support to the Comprehensive Everglades Restoration Plan (CERP) in Florida and California's Bay-Delta Restoration Program. When the Congress approved Florida's 30-year, $7.8 billion CERP in the Water Resources Development Act of 2000, it authorized $700 million in appropriations for an initial set of projects.[35] (Recently, a draft progress report for the Congress put the final cost of the effort at $10.9 billion.[36] The state and the federal government are to share funding responsibilities equally.) CERP aims to restore natural hydrologic functions while meeting water-supply and flood-control objectives for agriculture and a growing urban sector in southern Florida. The strategy is to increase the storage of excess water in the rainy season to provide more water during the dry

32. According to the *Water Strategist*'s February 2003 "Annual Transaction Review," of the 200 transactions in 2002, only 15 were for such purposes. The *Water Strategist* may not record all of the trades in western water, but it is the only comprehensive source of information on water trades.

33. In Idaho, Oregon, and Washington, only state agencies can dedicate unappropriated water to in-stream flows. (See Idaho Code §42-1503, Or. Rev. Stat. §537.336, and Wash. Rev. Code §§90.03.247, 90.22.010.) Furthermore, the prior appropriation doctrine limits the prospects for such dedications because water in most western streams is already fully appropriated. In Colorado, for example, since 1973 the state-run Colorado Water Conservation Board has been allowed to appropriate minimum stream flows and lake levels for the preservation of the natural environment "to a reasonable degree." However, because post-1973 water rights are relatively junior in priority, flows are available only in years when there is sufficient water to satisfy all of the rights of senior appropriators. In 1986, the state authorized the Colorado Water Conservation Board to buy or accept the donation of senior appropriators' water rights and use them for in-stream flows (see Colo. Rev. Stat. §37-92-102).

34. U.S. Census Bureau, "States Ranked by Percent Population Change: 1990 to 2000," Census 2000 PHC-T-2 (April 2, 2001), Table 3, available at www.census.gov/population/cen2000/phc-t2/tab03.pdf.

35. No additional projects have been authorized since 2000. Authorization for $1.6 billion for two projects is included in pending legislation, the Water Resources Development Act. Still, the federal government contributes to Everglades restoration through appropriations for CERP and other activities spread among several agencies. From fiscal years 1993 through 2005, the combined federal investment in Everglades restoration totaled about $2.5 billion. For fiscal year 2006, the Congress appropriated $223 million.

36. Army Corps of Engineers, *Comprehensive Everglades Restoration Plan*, 2005 Report to Congress (2005).

season. Officials plan to direct an estimated 80 percent of the captured water to the natural system and 20 percent to agriculture and urban consumption.

The CALFED program, established by the federal government and California in 1995, aims to restore fish and wildlife habitat, protect levees in the San Francisco Bay/Sacramento-San Joaquin Delta area in central California, and address issues of the reliability and quality of the water supply—including drinking water. The California Bay-Delta Environmental Enhancement Act of 1996 authorized a total of $430 million for fiscal years 1998 through 2000, and the Congress appropriated $220 million for CALFED activities during that period. The Congress provided an additional $68 million for activities supporting CALFED goals in fiscal year 2001.[37] The Water Supply, Reliability, and Environmental Improvement Act, signed by the President in October 2004, authorized $389 million in fiscal years 2005 through 2010 for the federal share of CALFED's costs; the Congress appropriated $37 million in 2006.

As the population shifts to arid areas, water markets (if they are allowed to operate) might play an important role in managing the changes in water demand in a way that yields the greatest possible net benefits to society.

Drought and Climate

Currently, the federal government spends an average of $1.3 billion per year on drought relief for farmers. That relief, which can vary substantially from year to year, is mostly in the form of crop insurance and crop disaster payments and mostly for nonirrigated land.[38]

The U.S. Department of Agriculture (USDA) administers three permanently authorized programs that provide drought relief: the Federal Crop Insurance Program, the Noninsured Crop Disaster Assistance Program, and the Emergency Loan Assistance Program. Those programs accounted for 56 percent of the estimated net federal outlays for drought relief for agriculture from 1989 through 2004 (see Figure 1). The Federal Crop Insurance Program protects producers from risks related to adverse weather (as well as plant diseases and insect infestations). Private companies sell and service the policies and are reinsured by USDA. The government absorbs a large percentage of the program's losses, subsidizes a portion of the premiums paid by participating producers, compensates the companies for some of their operating and administrative expenses, and pays the program's federal administrative costs. Under the Noninsured Crop Disaster Assistance Program, producers of a crop that is ineligible for insurance may be paid for any shortfall in yield under 50 percent of normal yield at 55 percent of the expected price. Producers must apply for coverage before planting and pay a fee of $100 per crop per county. The Emergency Loan Assistance Program offers favorable loan terms to help producers recover from production and physical losses.

The federal government determines when to provide emergency drought assistance by using a drought index that combines data on various indicators of water supply. Supplemental appropriations for crop-loss disaster programs and other assistance programs authorized as droughts occur accounted for 44 percent of the estimated net federal outlays for drought relief for agriculture from 1989 through 2004. Generally, with the disaster programs, producers with yields of less than 65 percent of normal received compensation for 65 percent of the expected crop price. (In some years, the Congress reduced payments because of funding caps or because it limited eligibility to one of several crop years.)

Other assistance programs authorized as events occur are ones for livestock assistance, disaster reserve assistance, pasture recovery, dairy production assistance, livestock indemnity, tree assistance, and emergency conservation.

Nonagricultural sectors are also affected by drought. While there are federal programs that provide targeted relief, they have had a comparatively limited impact on the federal budget. Communities that meet certain thresholds of drought-related job losses may apply to the Department of Commerce's Economic Development

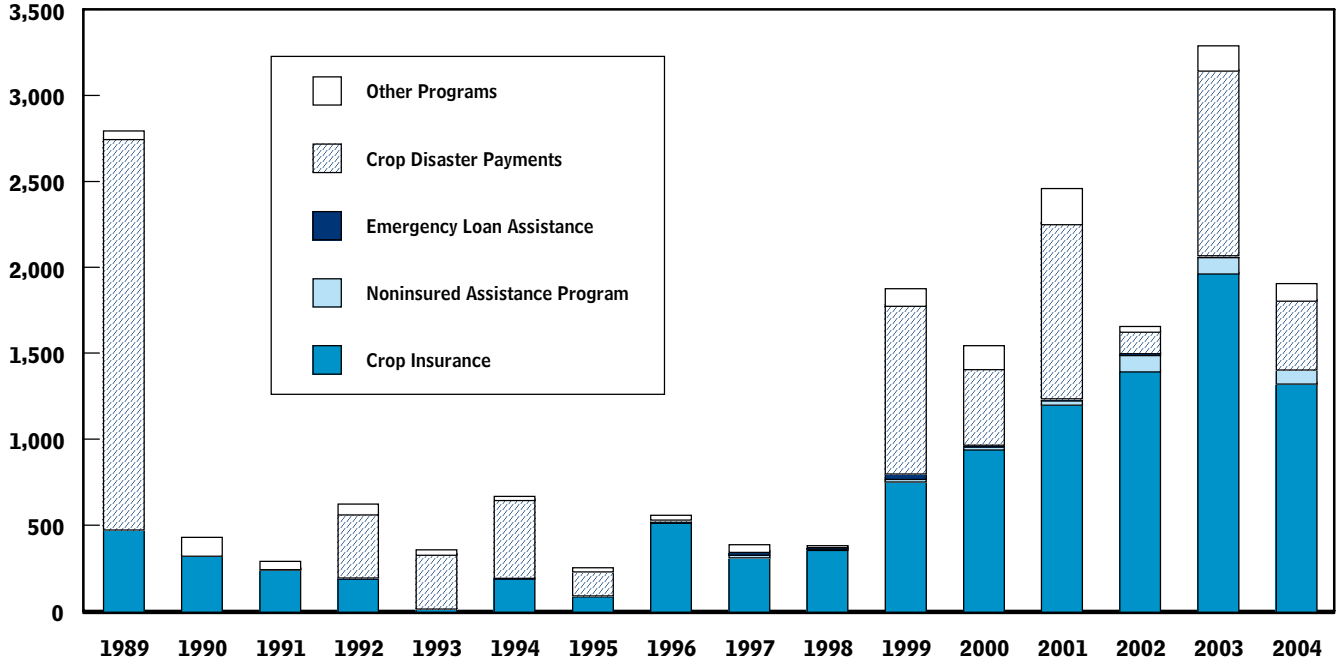
37. The Congress used the Water and Related Resources appropriation within various programs of the Central Valley Project because it lacked specific authorizing legislation.

38. In estimating the proportion of federal expenditures associated with crop loss that can be attributed to drought (as opposed to flood, hail, freezing, wind, insects, disease, and so forth), the Congressional Budget Office used cause-of-loss data provided by the Federal Crop Insurance Program.

Figure 1.

Drought Relief: Net Federal Outlays for Agriculture

(Millions of nominal dollars, by fiscal year)



Source: Congressional Budget Office based on data from the Department of Agriculture.

Notes: The federal government paid $1.48 billion to farmers under the Disaster Assistance Act of 1989, but it was not recorded directly as an outlay for crop disaster because farmers were paid in generic certificates. That payment is not included here, nor are outlays for administrative expenses.

Other programs include ones for emergency conservation and for livestock, dairy, tree, and pasture assistance.

Administration for grants to help organize and carry out planning processes and support activities—such as the creation and expansion of targeted business development and the construction of infrastructure improvements. Rural communities can receive federal drought assistance through Emergency Community Water Assistance grants if they have a significant decline in the quantity or quality of their drinking water. The Army Corps of Engineers can provide emergency water supplies for human consumption when an inadequate supply is likely to cause a substantial threat to public health and welfare. Small businesses that have suffered substantial economic injury (becoming unable to meet obligations as they mature and to pay ordinary and necessary operating expenses) because of a designated drought and are unable to obtain credit elsewhere may be eligible for the Small Business Administration's Economic Injury Disaster Loan Program.

Federal costs for drought response could be affected by the prospective impacts of climate change. Although those impacts are uncertain, researchers anticipate that the frequency and intensity of droughts (and floods) will change across the nation (reliable projections for specific areas are not available).[39]

Markets could allocate water more flexibly and thereby mitigate the potential costs of adapting to changing conditions for drought and to potential climate-related changes in water demand (associated with higher temperatures and the loss of water to the atmosphere through evaporation and plants' release of water vapor) and supply (because of shifting patterns in the amount, timing, and

39. See Congressional Budget Office, *Uncertainty in Analyzing Climate Change: Policy Implications* (January 2005).

location of precipitation as well as saltwater's intrusion in coastal areas).

Policy Options to Facilitate Reallocations

The federal government has a role in determining how the nation allocates and uses its water resources, despite the extent of the states' jurisdiction over water. To encourage a greater role for market mechanisms that might improve on the largely administrative allocation that has emerged under state law, the federal government could facilitate water marketing in the contexts of the commerce clause of the Constitution and federally reserved water rights. The federal government could also increase its efforts to promote water banks, which facilitate the legal transfer and market exchange of various types of entitlements for surface water, groundwater, and storage.

To encourage efficient water use, the government could reconsider existing subsidies for water delivery and for agricultural products. By distorting price signals, such subsidies impede the transfer of water resources to higher-value uses. The government could also evaluate refinements or expansions of programs that address water demand directly—such as conservation plans and cost-sharing programs for improvements to irrigation systems.

To encourage the efficient provision of water, the government could examine whether federal support for supply-augmenting research and development is appropriate to correct for the market failures associated with less-than-optimal levels of investment.

Facilitating Water Markets

The federal government could clarify the potential for broader geographic water marketing using its jurisdiction under the commerce clause of the Constitution and federally reserved water rights. The commerce clause gives the Congress the authority to allocate interstate waters to serve the national interest—even if doing so means overriding state law. Clarification of legal uncertainties about the rights of Indian tribes to lease water to different intrastate and interstate users could increase opportunities for tribes to transfer water. The government could also facilitate a greater role for water banks, which have emerged to address allocation issues in the context of the Endangered Species Act but have the potential for broader use.[40]

The Commerce Clause. Key to understanding how the commerce clause of the Constitution governs the interstate sale of water is the Supreme Court's 1982 decision in *Sporhase v. Nebraska* (see Box 4). With that decision, the Court opened the door to interstate water sales and federal control of those sales. States have pursued ways to try to close the door again.

In response to the *Sporhase* decision, states have essentially taken two approaches to limit out-of-state transfers of water. Some states, such as Colorado and Arizona, have laws intended to take advantage of the Supreme Court's acknowledgment that states may protect the health and safety of their own citizens by extending a "limited preference" to their citizens to preserve water "in time of severe shortage." There have been no cases testing the application of those statutes.[41] Other states, such as Montana and New Mexico, have appropriated water and given themselves the authority to lease it to those wishing to use it. That approach is intended to take advantage of an exception to the commerce clause under which states are

40. The geographic scope of water markets is limited by the impact of conveyance costs on the viability of transfers. In the West, markets have developed in some locations where they are supported by the relative economic value of water in different uses and the costs of conveyance—which can be significant. A 2002 transaction between a northern California irrigation district and the Metropolitan Water District serving Los Angeles, for example, carried an option purchase price for water of $100 per acre-foot, while the cost of the 300-mile transport (including pumping fees and a mandatory 20 percent environmental mitigation charge) was about $143 per acre-foot.

41. In *El Paso v. Reynolds*, 597 F. Supp. 694 (D.N.M. 1984), the court held that a statute similar to the constitutional portions of the statute addressed in *Sporhase* (for example, one restricting export if it would be "detrimental to the public welfare of the state") was on its face constitutional. The impact of the commerce clause in such cases has yet to be challenged in court.

Box 4.

Interstate Commerce in Water

In the case of *Sporhase v. Nebraska,* the Supreme Court held for the first time that water was covered by the commerce clause of the Constitution.[1] The case involved ownership of contiguous tracts of land in Nebraska and Colorado. A well on the Nebraska tract pumped groundwater to irrigate both tracts, thereby exporting water to Colorado. Nebraska law required a permit to export groundwater. For the landowners to obtain a permit, the withdrawal of groundwater had to be reasonable, not contrary to the conservation and use of groundwater, and not otherwise detrimental to the public welfare; and the state in which the water would be used had to grant reciprocal rights for its groundwater to be used in Nebraska. Because Colorado prohibited any export of its water, the landowners did not have a permit. Nebraska sued them to prevent the transfer of water across the border.

Water was clearly an article of commerce under some state law—which permitted groundwater to be extracted, bought, and sold—but not in Nebraska, where landowners could only extract groundwater needed for their land. Noting that the federal government had a significant interest in conservation and fair allocation of this resource, the Supreme Court concluded that the power of the Congress to legislate in the area could not be limited depending on whether a particular state considered water to be an article of commerce.

Even though the federal government may regulate interstate commerce in water, Nebraska is not without power to regulate its own water resources. Regarding state laws that do not directly impede interstate commerce, the Supreme Court had written: "Where the statute regulates evenhandedly to effectuate a legitimate local public interest, and its effects on interstate commerce are only incidental, it will be upheld unless the burden imposed on such commerce is clearly excessive in relation to the putative local benefits. If a legitimate local purpose is found, then the question becomes one of degree. And the extent of the burden that will be tolerated will of course depend on the nature of the local interest involved, and on whether it could be promoted as well with a lesser impact on interstate activities."[2]

Under that standard, the Supreme Court concluded that the first three conditions necessary for Nebraska to grant an export permit did not impermissibly burden interstate commerce. The Court described a "limited preference" that a state may grant its own citizens in the use of groundwater. Moreover, the Court observed that the expectation that each state may restrict water within its borders in certain circumstances has been fostered by equitable apportionment decrees and by interstate compacts. However, the fourth condition for obtaining an export permit (state reciprocity) represented an explicit barrier to interstate commerce and failed the "strictest scrutiny" tests of "significantly advancing" the goal of preserving and conserving groundwater, there being no adequate nondiscriminatory alternatives.

1. 458 U.S. 941 (1982). The decision overruled an earlier one, *Hudson County Water Co. v. McCarter* (209 U.S. 349 (1908)), in which the Court upheld a 1905 New Jersey statute prohibiting the export of water to any other state, ruling that water was not subject to the commerce clause because it was owned in trust for the public. In the decades that followed, many state legislatures—particularly in the West—enacted statutes prohibiting or significantly restricting the interstate export of water.

2. Quoting *Pike v. Bruce Church, Inc.,* 397 U.S. 137, 142 (1970).

themselves market participants rather than regulators.[42] Again, no neighboring state or other party has brought suit testing those post-*Sporhase* export restrictions.[43]

Federally Reserved Water Rights. Policymakers could act to make more water resources available to markets as claims for federally reserved water rights continue to be settled. Many water-rights settlements include provisions that authorize the sale or lease of water for off-reservation use (see the appendix to this paper). For example, the Arizona Water Settlements Act, approved by the Congress in December 2004, resolves the water-rights claims of the Gila River Indian Community and the Tohono O'odham Nation, allotting about half of the 1.5 million acre-feet of water flowing through the Central Arizona Project to Indian tribes. Although the settlement explicitly prohibits the out-of-state marketing of water newly reallocated to the tribes, it allows the tribes to transfer water to in-state non-Indian water users.[44]

Whether tribes can lease surface water to different users within and beyond state boundaries is an open question. Neither Supreme Court decisions nor federal laws have recognized a general tribal authority to convey water off-reservation. Also, many observers argue that the Non-Intercourse Act limits the ability of non-Indians to obtain rights to Indian water without Congressional approval and would operate to prohibit a lease of water off-reservation.[45] Still, legislative action might be taken in specific federally reserved water-rights settlements to authorize market transactions that move the water involved to higher-value uses, generating greater economic benefits for both nontribal and tribal communities.

Water Banks. Water banks are institutional mechanisms through which water-rights holders (typically irrigators) can receive compensation for letting others use their rights for a specified period. Most water banks are relatively new—few were established before 1990—and were set up primarily to aid compliance with the Endangered Species Act.[46] Most banks restrict the number and type of participants. The level of market activity varies widely

42. Only Montana may appropriate water for consumption in excess of 4,000 acre-feet per year and 5.5 cubic feet per second or from six river basins for transport outside those basins, and the state leases that water to those wishing to use it. (See Mont. Code Ann. §§85-2-141(10), -301(2).) New Mexico has legislation authorizing a long-term state appropriation and leasing program. It does not bar private water appropriations but allows state appropriations to exist unexercised for up to a century. Significant state appropriations in various regions would leave little unappropriated water for private appropriation, while state-appropriated water would be available for leasing. (See N.M. Stat. Ann. §§72-14-43, -44.)

43. Some observers have argued that Congressionally approved interstate compacts that explicitly or implicitly authorize export restrictions are insulated from the *Sporhase* decision. (See, for example, Sharon P. Gross, "The Galloway Project and the Colorado River Compacts: Will the Compacts Bar Transbasin Water Diversions?" *Natural Resources Journal*, vol. 25 (1985), p. 935.) However, the Supreme Court stated in *Sporhase* that where it has found a Congressional "intent and policy" to sustain state legislation in the face of the commerce clause, that intent was "expressly stated." That would be the case with the Yellowstone River Compact, which expressly prohibits interbasin export without the consent of all state parties to the compact. (See consent to the Yellowstone River Compact, ch. 629, 65 Stat. 663, 669 (1951).) However, it is not at all clear that export restrictions that are only implicitly based on interstate compacts will withstand scrutiny by the Supreme Court. (See Chris Seldin, "Comment: Interstate Marketing of Indian Water Rights: The Impact of the Commerce Clause," *California Law Review*, vol. 87 (1999), pp. 1555-1556.)

44. Some observers argue that this provision simply ensures that some of the water is sold back to the non-Indian irrigators who, under the terms of the settlement, relinquished their water use (to satisfy federally reserved rights) in exchange for federal forgiveness of a portion of their debt for the construction of the Central Arizona Project. In negotiating settlements, non-Indian entities and state governments have an incentive to prevent significant losses of water available for non-Indian users and to keep tribal water within state boundaries so as not to lose the state's share of water resources.

45. 25 U.S.C. §177. Note that tribal water is charged against a state's allocated share of interstate surface water resources established by interstate compacts, so the export of water by tribes presents a threat to the entitlements provided under the compacts. See Chris Selden, "Comment: Interstate Marketing of Indian Water Rights."

46. Requirements under the Endangered Species Act were the major catalyst for the formation of the Edwards Aquifer Bank in Texas, the Environmental Water Account in California, and the Klamath Basin bank in Oregon and California, among others.

among banks, but most generally have fewer than five trades a year.[47]

The Arizona Water Bank, created by the state legislature in 1996, illustrates the potential for banks to facilitate water markets, in this case between states. Water from the Colorado River conveyed through the Central Arizona Project recharges groundwater aquifers, generating future recovery rights that users can draw on at a later time. The bank gives California and Nevada access to as much as 100,000 acre-feet per year of Arizona's Colorado River allotment. In years when there is a surplus, the states can pay for the bank to store water that would otherwise go unused; in years when there is a shortage, California and Nevada can draw on banked supplies.[48]

In 1999, the Department of the Interior issued regulations for the broad implementation of that interstate water banking in the Lower Colorado River Basin.[49] The regulations operate within the limits of the "Law of the River"—the body of law governing the allocation of water from the Colorado River, which encompasses at least four different legal regimes (U.S. federal and state laws, Mexican domestic law, and international law). A water bank customer in California, Nevada, or Arizona (if empowered by state law) can develop an "intentionally created unused apportionment" (ICUA) and store it in another Lower Basin state's bank. That bank can release stored water for parties that have banked ICUAs. The bank can also release water on credit, in anticipation of an equal amount of subsequent water stored in the same year. Parties can sell banked water if they have state authorization and the approval of all parties to the agreement.

An interstate water-banking model like that one might facilitate future water transfers in the broader Colorado River Basin. Arranging for Upper Basin states, which have never used their full apportionment, to bank Colorado River water for potential use by Lower Basin states might direct resources to higher-value uses.[50]

Encouraging the Efficient Use of Water

The federal government influences the demand for water through various subsidies and programs. Subsidies for water infrastructure and agricultural production encourage the use of water resources, whereas programs that target agricultural and municipal reductions in water use reduce demand. Policymakers could reconsider subsidies for water infrastructure to promote pricing that better reflects the opportunity costs associated with agricultural use of water provided through federal facilities and with municipal and industrial uses of water for which the costs may exceed the benefits.

Policymakers could also reconsider agricultural marketing loans and support programs for the sugar and dairy industries. Those three programs, by increasing the value of water maintained in agriculture through their impact on production, make transferring water to nonagricultural uses more difficult and expensive for prospective purchasers. In the West, where irrigation accounts for such a large share of freshwater withdrawals, such programs may significantly reduce the amount of water available for nonagricultural use.

47. Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Texas, and Washington have all made use of water banks. For a summary table of water-banking programs in the West and their features, see Peggy Clifford, Caly Landry, and Andrea Larsen-Hayden, "Analysis of Water Banks in the Western United States," Publication No. 04-11-011 (Washington State Department of Ecology and WestWater Research Analysis, July 2004).

48. The Arizona Water Bank restricts California's access to Arizona's unused Colorado River water. A 1930s-era pact gave California 1 million acre-feet more than the state's allotment of Colorado River water under the federal law that primarily governs water allocation within the Lower Colorado River Basin. That additional water would come from the unused apportionments of the other states as well as the occasional "surplus" flows. With the operation of the Arizona Water Bank, however, both Arizona and Nevada used nearly their full apportionments in 1996, and California had to rely on the Secretary of the Interior's annual designations of surpluses to avoid losing a significant portion of its water. As a result, in 1999, an agreement was reached in which California took a major step toward gradually reducing its annual use of Colorado River water to 4.4 million acre-feet.

49. 43 C.F.R. § 414.

50. Under the Challenge Grant Program of the Department of the Interior's Water 2025 Initiative (funded at $4 million, $11 million, and $5 million in fiscal years 2004, 2005, and 2006, respectively), the Bureau of Reclamation provides half of the costs of projects (initiated by irrigation and water districts or states) that focus on water conservation, efficiency, and water marketing and can be completed in two years. Thus far, only one of the projects (which the bureau selects through a competitive process) directly addresses promoting markets. A 2004 grant of nearly $250,000 was awarded to the Central Oregon Irrigation District in Bend for a project to establish a pilot water bank involving many partners—seven irrigation districts, six cities, three tribes, and the Deschutes Resource Conservancy.

To further explore potential gains to the economy from the use of water resources, the federal government might also assess the impact of refining or expanding its cost-sharing program for improvements to irrigation systems, its conservation plans for irrigation districts supplied by the Bureau of Reclamation, and its water-efficiency standards for plumbing applications.

Subsidies for Water Infrastructure. Water infrastructure is the physical structures used to store and distribute water. One option for encouraging efficient water use would be to phase out infrastructure subsidies that support the delivery of water to agricultural and municipal users at rates that generally do not cover costs. Changes that move water prices toward levels that correspond more closely to opportunity costs encourage more beneficial use of water resources economywide.

The less one pays for water, the more water one is likely to use. Studies gauging the price responsiveness of demand for irrigation water have found a wide range of effects: for a 10 percent increase in the price of water, estimated declines in use have ranged from 1 percent to 20.3 percent.[51] The differences may reflect assumptions about the effect of changes in water prices on new distribution capacity, the effect of changes in the prices of agricultural products on the demand for them, and the extent to which irrigators are informed about the price of each additional unit of water.

Studies gauging the price responsiveness of residential demand for water have generally been seen as suggesting that changes in price have little effect on use. However, existing estimates do not indicate the potential responsiveness of water use to price changes outside the narrow range seen in those studies. A 1997 review of 24 such studies of residential water demand found that a 10 percent increase in the price of water corresponded to estimated declines in use ranging from 0.2 percent to 33.3 percent, with an average decline of 5.1 percent. (About three-quarters of the estimates were between 0.2 percent and 7.5 percent.)[52] Notably, the mean price for water (in 2000 dollars) in various locations in the United States used for empirical studies is about $0.0022 per gallon, and it ranges from $0.0001 to $0.0035. At such prices, a user's cost for daily 10-minute showers over the course of a month (using a 7.5-gallon-per-minute showerhead) totals only $5.00.[53]

Subsidies for Agricultural Production. The federal government subsidizes the production of crops through its marketing loan system. Marketing loan provisions allow farmers to repay commodity loans (nine- or 10-month government loans for which farmers pledge production as collateral) at less than the original loan rate (plus interest) when market prices are lower. Loan rates affect producers' decisions about how much to plant, and thus their demand for water, because the income support provided through marketing loans is based on current production and prices.

The marketing loan system increased production of wheat by an estimated 2.5 percent, corn and soybeans by an estimated 1.5 percent, and cotton by an estimated 10 percent in 2000.[54] One analysis of adjustments in the 2002 farm bill estimated that they would prompt a 1 percent increase in the acreage that producers planted with major field crops.[55]

Marketing loans for rice and upland cotton began with the provisions of the 1985 farm bill; subsequent legislation made them available for soybeans and other oilseeds starting in 1991, and they became available for wheat and feed grains beginning with the 1993 crop year. The 2002 farm bill, which governs programs through 2007, removed the Department of Agriculture's discretionary authority to reduce payment rates for marketing loan price supports when market prices fall. It raised rates for most crops (lowering them only for soybeans and holding

51. Mark Kanazawa, "Pricing Subsidies and Economic Efficiency: The U.S. Bureau of Reclamation," *Journal of Law and Economics*, vol. 36 (April 1993), pp. 205-234.

52. M. Espey, J. Espey, and D. Shaw, "Price Elasticity of Residential Demand for Water: A Meta-Analysis," *Water Resources Research,* vol. 33, no. 6 (1997), pp. 1369-1374. Also see Sylvestre Gaudin, "Effect of Price Information on Residential Water Demand," *Applied Economics,* vol. 38, no. 4, (2006), pp. 383-393.

53. David S. Brookshire and others, "Western Urban Water Demand," *Natural Resources Journal*, vol. 42, no. 4 (Fall 2002), pp. 873-898.

54. See P.C. Westcott and J.M. Price, "Analysis of the U.S. Commodity Loan Program with Marketing Loan Provisions," Department of Agriculture, Economics Research Service, Agricultural Economics Report No. 801 (April 2001); and B.L. Gardener, "Agricultural Policy: Pre- and Post-FAIR Act Comparisons," Policy Analysis Report 01-02 (College Park, Md.: University of Maryland, Center for Agriculture and Natural Resource Policy, 2002).

55. Paul Westcott, "Marketing Loan Rates and Acreage Response," *Choices* (Fourth Quarter 2003), pp. 31-34.

them constant for rice) and extended marketing loans to six new crops. Producers can receive the payments on all current production.

Federal support for the production of sugar also encourages agricultural water use. Sugar beets are one of the most water-intensive crops grown in the West—approximately 75 percent of the typical sugar beet root consists of water. The farm bills of the early 1980s reinstated mandatory price supports for the sugar industry (after the initial sugar program expired in 1974), and later bills extended the supports through 2007.[56] The federal government protects the price of sugar by restricting imports, making below-market-rate loans available to processors, and limiting the amount of sugar that processors can sell domestically. Because of that support, domestic growers' supply for the national sugar market increased from roughly 55 percent of the total prior to the early 1980s to 86 percent in 2005.[57] One recent analysis of the prices supported by federal import restrictions estimated that they generate a 5 percent to 6 percent increase in the nation's acreage devoted to sugar beet production, with corresponding needs for agricultural water use.[58]

Federal support for dairy producers also encourages agricultural water use by promoting the production of alfalfa for feed. Alfalfa is another water-intensive crop, accounting for nearly 20 percent of the irrigation water applied in western states.[59] Dairy price supports take the form of federal purchases of surplus dairy products when market prices are low, federal milk-marketing orders that regulate the farm price of milk for roughly two-thirds of national production by requiring processors to pay minimum prices, and countercyclical payments under "milk-income loss contracts" when prices fall below a certain target.[60]

Conservation Programs. Federal cost-sharing programs for improvements to irrigation systems provide payments to offset agricultural producers' costs of adopting more-advanced irrigation technology. Those programs might be more effective if they targeted larger farms. Nearly 75 percent of the farms that did not participate in public cost-sharing programs between 1994 and 1998 accounted for over 80 percent of irrigated farms in the West. Of those, the larger farms (those with annual sales of over $250,000) accounted for more than 60 percent of the irrigated acreage and more than 65 percent of the farm water applied. Moreover, the largest 10 percent of irrigated farms (those with annual sales in excess of $500,000) accounted for almost half of the total farm water applied.[61]

Federally required conservation plans for irrigation districts that have their water supplied by the Bureau of Reclamation improve the reliability of existing water supplies, postpone the need for new or expanded water supplies, and reduce the impact of drought. Those plans might have a greater impact on farm water conservation if requirements and enforcement were more stringent. Under the Reclamation Reform Act of 1982, for instance, irrigation districts select their own conservation goals—which can be broadly defined and even inconsistent with the original intent of the requirements. Furthermore, although conservation plans were originally due by early 1987, by 1996 fewer than half of the nearly 500 affected districts had submitted a plan, and the Congress provided neither specific enforcement authority, nor an enforcement mechanism, to use with districts that did not

56. The government provided mandatory price support in 1977 and 1978 and discretionary support in 1979.

57. Congressional Research Service, *Sugar Policy Issues,* CRS Issue Brief for Congress IB95117 (February 16, 2006).

58. J.C. Beghin and others, *The Cost of the U.S. Sugar Program Revisited*, Working Paper 01-WP 273 (Ames, Iowa: Iowa State University, Center for Agriculture and Rural Development, 2001).

59. Department of Agriculture, National Agricultural Statistics Service, *1997 Census of Agriculture,* vol. 3, *Special Studies, 1998 Farm and Ranch Irrigation Survey*, Report AC97-SP-1 (1999).

60. The Deficit Reduction Act of 2005 (Public Law 109-171) includes a two-year extension of the program that provides milk-income loss contracts. See Congressional Research Service, *Dairy Policy Issues*, CRS Issue Brief for Congress IB97001 (January 10, 2006).

61. Department of Agriculture, Economic Research Service, "Briefing Room: Irrigation and Water Use - Questions and Answers" (May 28, 2004), available at www.ers.usda.gov/Briefing/WaterUse/Questions.

    Improved irrigation efficiency may not translate into water savings if it reduces the amount of reusable water (reusable runoff and excess deep percolation) that represents an important source of water for downstream withdrawals and environmental purposes. Potential conservation programs could focus on assessing salvage amounts and costs associated with technologies to target water that is not reusable—reducing evaporation losses from sprinklers, water surfaces, and excessively wet soil; reducing transpiration from unwanted plants; and reducing runoff that is of impaired quality.

comply.[62] With the Central Valley Project Improvement Act of 1992, the Congress did introduce narrower requirements for plans and an enforcement mechanism. That law generally requires that irrigation districts' plans include some form of conservation pricing, and districts without a federally approved plan are subject to an increase in their water costs. Applied more widely, such price-based compliance incentives might yield greater net benefits from the use of water resources.

Some analysts have suggested that the federal water-efficiency standards enacted with the Energy Policy Act of 1992 (which mandated the use of water-efficient plumbing fixtures) increased society's net benefits and that standards for additional plumbing applications could do the same.[63] More broadly, water prices that were more closely aligned with costs could encourage conservation and efficient water use by broad classes of consumers.

Encouraging the Efficient Provision of Water

The government has directed budgetary resources to the creation of additional water supplies through research and development (R&D) of technologies to desalinate and to purify water.[64] The United States spent more than $1 billion (in 1999 dollars) on such R&D, beginning with the Saline Water Act of 1952 and continuing until 1982, when most federal funding for that activity was discontinued. Since the 1990s, additional nominal appropriations have amounted to about $330 million.[65]

In addition, to support decisionmaking for long-term water management, the federal government has funded the collection of data on streamflow and groundwater levels specifically to enhance the reliability of predictive models. The U.S. Geological Survey (USGS) has collected streamflow information since 1889. The agency operates a national network of about 7,200 stream gauges, which measure and record the quantity and variability of water flows. The number of gauges has remained relatively constant, but there have been fewer and fewer gauges with 30 or more years of records. From 1990 to 2001, the agency discontinued 690 gauges because of funding constraints.

Efforts to collect data on groundwater levels present other difficulties. There is no comprehensive groundwater-level monitoring network with uniform coverage of major aquifers. Researchers do not use standardized approaches at similar spatial or temporal scales in gathering data on levels and rates of change, threatening the long-term viability of current efforts. A recent poll of USGS district offices and state and local water agencies indicated that there were about 42,000 observation wells (the principal source of information about groundwater systems) in the United States with five years (a relatively short period) or more data on water levels. Many of those long-term monitoring wells are clustered in certain areas; since the 1980s, the number monitored by the USGS has declined by about half because of limitations in funding and personnel.

In general, when multiple and separate public- and private-sector entities face a similar problem, they tend to invest too little in R&D, because each balances the potential cost of research against only its own expected benefits, rather than the benefits that can accrue to all parties. Federal investment in research and development of desalination and water-purification technologies and in the collection of information addresses such a market failure. Determining the level of federal support merited by such considerations is a challenge, however. It depends on the typically difficult-to-predict results from the investment

62. Department of the Interior, Bureau of Reclamation, *Final Environmental Impact Statement: Proposed Acreage Limitation and Water Conservation Rules and Regulations*, Pub. No. FES 96-7 (Denver, Colo., February 2, 1996); and Department of the Interior, Bureau of Reclamation, *Reclamation Policy for Administering Water Conservation Plans Pursuant to Statutory and Contractual Requirements* (Denver, Colo., 1996).

63. Peter Gleick and others, *Waste Not, Want Not: The Potential for Urban Water Conservation in California* (Oakland, Calif.: Pacific Institute for Studies in Development, Environment, and Security, November 2003).

64. Desalination and water-recycling technologies currently make a very small contribution to water supplies in the United States. At the end of the 1990s, nearly 800 desalination plants (many for industrial use) in 46 states provided about 1.4 percent of residential and industrial water, and the nearly 2 million acre-feet of water recycled annually in the early 2000s was not significant on a national scale.

65. See Congressional Research Service, *Desalination R&D: The New Federal Program*, CRS Report for Congress RS20069 (February 18, 1999); statement of Maryanne Bach, Director of Research and Development for the Bureau of Reclamation, before the Subcommittee on Water and Power of the House Committee on Resources, *Bureau of Reclamation Activities Related to Desalination Research and Development for Informational Purposes in Connection with H.R. 1071* (May 24, 2005); and statement of Betsy A. Cody, Congressional Research Service, before the Subcommittee on Water and Power of the House Committee on Resources, *Federal Role in Reclamation Water Reuse and Recycling: Developments in Implementation of Title XVI* (March 27, 2003).

and on the extent to which nonfederal entities change their R&D expenditures in response to increased federal funding.[66]

More traditionally, the federal government has relied on building dams and conveyance systems to develop additional water supplies. However, the economic justification for such federal investments depends on resolving several issues, including identifying the federal interest (which may be limited if the benefits of proposed projects accrue primarily within an individual location or state), avoiding distortionary subsidies for agriculture, charging prices for water that reflect its value, and accounting for uncertainties associated with the supply of freshwater.

66. The historically low price of water in the United States has probably also impeded the evolution of water treatment technologies (and thus their suitability for widespread use) because distorted price signals fail to communicate to private firms the benefits available to all parties from research and development.

Appendix: Marketing Features of Indian Water-Rights Settlements

It is an open question whether tribes can lease surface water to other users, either within the same state or in another state. There is no formal federal recognition of a general tribal authority to convey water off-reservation. Furthermore, many observers argue that federal laws limit the ability of non-Indians to obtain rights to Indian water without Congressional approval and that such laws would prohibit a lease of water off-reservation. Many water-rights settlements, however, include provisions that authorize the sale or lease of water for off-reservation use. This appendix lists the Indian water-rights settlements approved by the Congress that have water marketing features and describes the features allowed under the terms of each settlement (see Table A-1).

Table A-1.

Selected Indian Water-Rights Settlements

Settlement	State	Original Settlement Date	Water-Marketing Features
Arizona Water Settlements Act	Arizona	2004	Out-of-state marketing prohibited, but tribes may transfer water to in-state non-Indian users.
Shivwits Band of the Paiute Indian Tribe of Utah Water Rights Settlement Act	Utah	2000	Use or lease of water rights allowed for any beneficial use of the water off-reservation.
Chippewa Cree Tribe of the Rocky Boy's Reservation Indian Reserved Water Rights Settlement Act	Montana	1999	Transfer of any portion of water rights allowed for use of water off-reservation by service contract, lease, exchange, or other agreement, subject to the approval of the Secretary of the Interior and the state.
Yavapai-Prescott Indian Tribe Water Rights Settlement Act	Arizona	1994	Marketing of effluent generated on-reservation allowed.
Jicarilla Apache Tribe Water Settlement Act	New Mexico	1992	Subcontracting allowed on- or off-reservation with the Secretary of the Interior's approval and subject to state law.
Northern Cheyenne Indian Reserved Water Rights Settlement Act	Montana	1992	Transfers allowed on- and off-reservation, with most off-reservation marketing subject to state law.
Ute Indian Rights Settlement Act	Utah	1992	Future water sales possibly allowed by neutral marketing provisions, subject to the body of law governing the allocation of Colorado River water. Tribal water made subject to state law by the off-reservation leasing provision.
Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act	Nevada	1990	Limited transactions allowed, subject to state law.
Fort Hall Indian Water Right Act	Idaho	1990	Off-reservation leasing to local users allowed.
Fort McDowell Indian Community Water Rights Settlement Act	Arizona	1990	Off-reservation leasing of Central Arizona Project water limited to 99-year lease with the city of Phoenix.
Truckee-Carson-Pyramid Lake Water Right Act	Nevada/ California	1990	Limited transactions allowed, subject to state law.
Salt River Pima-Maricopa Indian Community Water Rights Settlement Act	Arizona	1988	Marketing limited to a lease-exchange agreement with the city of Phoenix.
San Luis Rey Indian Water Rights Settlement Act	California	1988	Intertribal entity established to market water.
Southern Arizona Water Rights Settlement Act	Arizona	1982	Limited off-reservation leasing allowed in Tucson Active Management Area.
Ak-Chin Indian Water Rights Settlement Act	Arizona	1978	Off-reservation leasing in certain nearby counties allowed by 1992 amendments.

Source: Congressional Budget Office based on information provided by Craig Bell, Western States Water Council, "Settlements Approved by Congress" (March 23, 2005), and Public Law 108-451, December 10, 2004.